

FORM PTO-1390 (Modified)
(REV 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

02:13

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

10/048160INTERNATIONAL APPLICATION NO.
PCT/GB 00/02868INTERNATIONAL FILING DATE
28 July 2000PRIORITY DATE CLAIMED
29 July 1999

TITLE OF INVENTION

DIAPHRAGM PUMPS

APPLICANT(S) FOR DO/EO/US

MACAULEY, Stephen EVASON, Michael MCFARLAND, Robert Stanley

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

Transmittal Sheets in Duplicate w/ fees charged to Depoist Acct. 07-2100-Copy of World Patent Application w/ 7 sheets drawings- Copy of Specification, Claims, and Abstract w/ 7 sheets drawings - Preliminary Amendment (Not Enclosed) - Copies of PCT/RO/101, PCT/ISA/210 and 220, PCT/IPEA/ 409 (Not Enclosed) - Executed Declaration and Assignment to Munster Simms Engineering Limited (Not Enclosed) - Small Entity Status Declaration (Not Enclosed)

| | | |
|---|---|--|
| U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.492(a)(1)-(5)) : 10/048160 | INTERNATIONAL APPLICATION NO. PCT/GB 00/02868 | ATTORNEY'S DOCKET NUMBER 02:13 |
|---|---|--|

24. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **\$1040.00**
- ☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **\$890.00**
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **\$740.00**
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **\$710.00**
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **\$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =**\$890.00**

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

\$130.00

| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE | | |
|--|--------------|--------------|-----------|--------------------------|---------------|
| Total claims | 13 - 20 = | 0 | x \$18.00 | \$0.00 | |
| Independent claims | - 3 = | 0 | x \$84.00 | \$0.00 | |
| Multiple Dependent Claims (check if applicable). | | | | <input type="checkbox"/> | \$0.00 |

TOTAL OF ABOVE CALCULATIONS =**\$1,020.00**

- ☒ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.

\$510.00**SUBTOTAL =****\$510.00**

Processing fee of **\$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).

\$0.00**TOTAL NATIONAL FEE =****\$510.00**

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).

☐**\$0.00****TOTAL FEES ENCLOSED =****\$510.00**

| | |
|---------------------------|----|
| Amount to be: refunded | \$ |
| charged | \$ |

- a. ☐ A check in the amount of _____ to cover the above fees is enclosed.
- b. ☒ Please charge my Deposit Account No. **07-2100** in the amount of **\$510.00** to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **07-2100** A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Ronald E. Greigg

NAME

31,517

REGISTRATION NUMBER

29 January 2002

DATE

10/048160.3

Rec'd PCT/PTO 24 MAY 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Stephen MACAULEY et al

Based on PCT/GB 00/02868

FOR: DIAPHRAGM PUMPS

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, between the title and paragraph [0001] insert the following:

[0000.1] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.2] This application is a 35 U.S.C. 371 application of PCT/GB 00/02868, filed on July 28, 2000.

[0000.3] BACKGROUND OF THE INVENTION

[0000.4] Field Of The Invention

between paragraphs [0000.5] and [0001] insert the following paragraph:

[0000.6] SUMMARY OF THE INVENTION

replace paragraph [0001] with the following amended paragraph:

[0001] The present invention is a diaphragm pump comprising a two part casing formed of a front cover and a back cover, a diaphragm plate extending across the covers and being secured therebetween when the covers are fastened together, the diaphragm plate having a plurality of similarly defined circular regions, the front cover having substantially axially aligned inlet and outlet ports, each leading to mutually exclusive

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inlet and outlet chambers respectively, a valve housing securable inside the front cover and having defined therein an outlet dished valve seat with a correspondingly concave resilient valve seated therein, the outlet valve seating having fluid passages therethrough, and a plurality of inlet valve seats, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein, each inlet valve seat having fluid passages therethrough, the outlet valve being in fluid communication with the outlet chamber and the inlet valves being in fluid communication with the inlet chamber, and a wobble plate positioned in the back cover and having a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm, the piston sections and circular regions being correspondingly secured together, the wobble plate being subject to nutating motion to cause reciprocating action by the circular regions and provide a pumping action.

Page 3, between paragraphs [0005] and [0006] insert the following:

[0005.5] **BRIEF DESCRIPTION OF THE DRAWINGS**

replace paragraph [0009] with the following amended paragraph:

[0009] Figs. 3A and 3B are respectively exploded perspective views from above and from below of a valve housing of the pump;

Page 4, between paragraphs [0015] and [0016] insert the following:

[0015.5] DESCRIPTION ON THE PREFERRED EMBODIMENTS

replace paragraph [0017] with the following amended paragraph:

[0017] The front cover 10 has substantially axially aligned inlet and outlet ports 18, 20, each leading to a mutually exclusive inlet and outlet chambers 22,24, respectively. The outlet chamber 24 is provided centrally of the front cover 10 and has a wall surround 25 through which the outlet port 20 communicates. The inlet chamber 22 is defined between the wall surround 25 and the sidewall of the front cover 10.

replace paragraph [0018] with the following amended paragraph:

[0018] A valve housing 26 is substantially planar and is secured inside the front cover 10 and has defined therein on one side an outlet dished valve seat 28 with a correspondingly concave resilient valve 30 seated therein. The outlet valve seat 28 has a gridded area 32 forming fluid passages therethrough and a central hole 72. On the opposite side of the housing 26, a plurality of four inlet valve seats 34 are provided, each being similarly dished and having a corresponding concave resilient valve 36 seated therein, each inlet valve seat 34 having arcuate gridded areas 38 forming fluid passages therethrough and a central hole 73. The outlet valve seat 28 is in fluid communication with outlet chamber 24 and the inlet valve seats 34 are in fluid communication with the inlet chamber 22. Each valve 30 and 36 is formed of a dished, part-spherical portion having a post 35 radially outstanding from its rear convex face, the post having bulbous portion 37, the valve being seated by the post 35 being pushed through the hole 72,73 respectively with the bulbous portion 37 holding the valve in position preventing unintentional removal.

Page 5, replace paragraph [0023] with the following amended paragraph:

[0023] The back cover 12 of the casing is secured to an electric motor 76 with the drive shaft connected via an eccentric 78 to the bearing 54 through the back cover 12. The eccentric 78 has a knurled portion 79 to fit into the wobble plate 40 with the drive shaft of the motor located in bore 81. The motor 76 has a mounting bracket 56 with a series of mounting feet 58 fitted thereto, the feet 58 each being substantially ovoid in plan and of resilient material to dampen vibratory movement. The greater dimensioned end of each foot 58 has an upstanding headed stub pillar 60, the pillar 60 mating in an open slot 62 in the bracket 56. The slot 62 is narrower at its open end to hold the respective foot 58 in the slot. The feet 58 are similarly provided with two fixing holes 64 at their narrower end and being capable of rotating in and about their respective mating slot 62.

Page 6, replace paragraph [0024] with the following amended paragraph:

[0024] The valve housing 26 is fixed to the front cover 10 by a screw (not shown). An integral pressure switch (not shown) is provided in the back cover 12 with the diaphragm plate 14 being provided with a fifth defined circular region 66, smaller than the other regions 16, the rear diaphragm support plate 50 having a similarly shaped aperture 68 with wall surround to accommodate the circular region 66. A micro-switch (not shown) is retained in an enclosure 82 on the back cover 12 by an upstand 80 in the rear diaphragm support plate 50, and is activated by movement of the fifth circular region 66 serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor. The valve housing 26, on the same side as the inlet valve seats 34 are positioned, is provided with a track 70 between two

inlet valve seats 34 leading from a hole 72 exiting on that side and centrally provided in the outlet valve seat 28 provided on the opposite side, the track 70 mating with a corresponding track 74 provided on the diaphragm plate 14. The mated tracks 70, 74 form a passage between the hole 72 and the fifth circular region 66 whereby any fluid leaving the outlet chamber 24 when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate 14 from the pressure switch causing activation of the micro-switch to stop the pump.

Page 7, after paragraph [0029] insert the following new paragraph:

[0030] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Page 8, line 1, delete "Claims" and insert--"We Claim"--.

IN THE CLAIMS

Please cancel claims 1-13 and add new claims 14-33.

14. A diaphragm pump comprising a two part casing formed of a front cover and a back cover, a diaphragm plate extending across the covers and being secured therebetween when the covers are fastened together, the diaphragm plate having a plurality of similarly defined circular regions, the front cover having substantially axially aligned inlet and outlet ports, each leading to mutually exclusive inlet and outlet chambers respectively, a valve housing securable inside the front cover and having defined therein an outlet dished valve seat with a correspondingly concave resilient valve seated therein, the outlet valve seating having fluid passages therethrough, and a plurality of inlet valve seats, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein, each inlet valve seat having fluid passages therethrough, the outlet valve being in fluid communication with the outlet chamber and the inlet valves being in fluid communication with the inlet chamber, and a wobble plate positioned in the back cover and having a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm, the piston sections and circular regions being correspondingly secured together, the wobble plate being subject to nutating motion to cause reciprocating action by the circular regions and provide a pumping action, the wobble plate boss seating and holding a bearing, the bearing having been insert moulded in the boss with the boss having an inwardly-extending retaining flange over the bearing.

15. A pump as claimed in Claim 14, wherein the circular regions of the diaphragm are each provided with an outstanding lug formation and the mating surfaces of the piston sections of the wobble plate are provided with complimentary shaped slots, the securement being formed when the lug formation of each region is engaged in the slot of the corresponding piston section.
16. A pump as claimed in Claim 15, wherein the lug formation of each diaphragm and the slot of each corresponding piston section is of cruciform shape.
17. A pump as claimed in Claim 15 wherein the outer ends of the lug formation are of greater length than the slots to provide a locking means in the slots.
18. A pump as claimed in Claim 16, wherein the outer ends of the lug formation are of greater length than the slots to provide a locking means in the slots.
19. A pump as claimed in Claim 14, wherein a rear diaphragm support plate is provided in the back cover, the support plate having an equal number of similar apertures to the numbers of circular regions, each aperture having a walled surround, the circular regions fitting into respective apertures and being supported thereby.
20. A pump as claimed in Claim 14, wherein the casing is secured to an electric motor with its drive shaft connected via an eccentric to the bearing.

21. A pump as claimed in Claim 19, wherein the casing is secured to an electric motor with its drive shaft connected via an eccentric to the bearing.

22. A pump as claimed in Claim 20, wherein the casing has a mounting bracket with a series of mounting feet fitted thereto, the feet each being substantially ovoid in plan and of resilient material, the greater dimensioned end having an upstanding headed stub pillar, each pillar mating in a open slot in the bracket, the slot being narrower at its open end to hold the respective foot in its slot.

23. A pump as claimed in Claim 14, wherein the valve housing is fixed to the front cover by a screw.

24. A pump as claimed in Claim 15, wherein the valve housing is fixed to the front cover by a screw.

25. A pump as claimed in Claim 19, wherein the valve housing is fixed to the front cover by a screw.

26. A pump as claimed in Claim 22, wherein the valve housing is fixed to the front cover by a screw.

27. A pump as claimed in Claim 14, further comprising an integral pressure switch provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch actuated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor.

28. A pump as claimed in Claim 15, further comprising an integral pressure switch provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch actuated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor.

29. A pump as claimed in Claim 19, further comprising an integral pressure switch provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch actuated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor.

30. A pump as claimed in Claim 20, further comprising an integral pressure switch provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch actuated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor.

31. A pump as claimed in Claim 14, wherein the valve housing, on the same side as the inlet valve seats are positioned, is provided with a track leading from a hole exiting on that side and centrally provided in the outlet valve seat provided on the opposite side, the track mating with a corresponding track provided on the diaphragm plate, the mated tracks forming a passage between the hole and the fifth circular region whereby any fluid leaving the outlet chamber when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate from the pressure switch causing activation of the micro-switch to stop the pump.

32. A pump as claimed in Claim 19, wherein the valve housing, on the same side as the inlet valve seats are positioned, is provided with a track leading from a hole exiting on that side and centrally provided in the outlet valve seat provided on the opposite side, the track mating with a corresponding track provided on the diaphragm plate, the mated tracks forming a passage between the hole and the fifth circular region whereby any fluid leaving the outlet chamber when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate from the pressure switch causing activation of the micro-switch to stop the pump.

33. A pump as claimed in Claim 22, wherein the valve housing, on the same side as the inlet valve seats are positioned, is provided with a track leading from a hole exiting on that side and centrally provided in the outlet valve seat provided on the opposite side, the track mating with a corresponding track provided on the diaphragm plate, the mated tracks forming a passage between the hole and the fifth circular region whereby any fluid leaving the outlet chamber when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate from the pressure switch causing activation of the micro-switch to stop the pump.

IN THE ABSTRACT

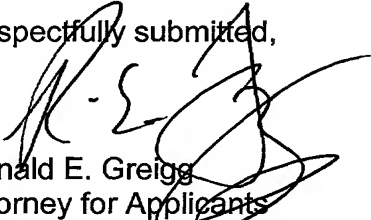
Please substitute the attached Abstract of the Disclosure with the abstract as originally filed.

REMARKS

The above amendments are being made to place the application in better condition for examination.

Entry of the amendment is respectfully solicited.

Respectfully submitted,


Ronald E. Greigg
Attorney for Applicants
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May 24, 2002

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ABSTRACT OF THE DISCLOSURE

A diaphragm pump comprises a two part casing formed of a front cover and a back cover. A diaphragm plate extends across the covers and is secured therebetween when the covers are fastened together. The diaphragm plate has a plurality of similarly defined circular regions. The front cover has substantially axially aligned inlet and outlet ports, each leading to mutually exclusive inlet and outlet chambers respectively. A valve housing is securable inside the front cover and has defined therein an outlet dished valve seat with a correspondingly concave resilient valve seated therein. The outlet valve seat has fluid passages therethrough. A plurality of inlet valve seats is provided, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein. Each inlet valve seat has fluid passages therethrough. The outlet valve is in fluid communication with the outlet chamber and the inlet valves are in fluid communication with the inlet chamber. A wobble plate is positioned in the back cover and has a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm plate. The piston sections and circular regions are correspondingly secured together. The wobble plate is subject to nutating motion to cause reciprocating action by the circular regions and provide a pumping action.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, between the title and paragraph [0001]:

[0000.1] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.2] This application is a 35 U.S.C. 371 application of PCT/GB 00/02868, filed on July 28, 2000.

[0000.3] BACKGROUND OF THE INVENTION

[0000.4] Field Of The Invention

between paragraphs [0000.5] and [0001]:

[0000.6] SUMMARY OF THE INVENTION

paragraph [0001]:

[0001] The [Accordingly, the] present invention is a diaphragm pump comprising a two part casing formed of a front cover and a back cover, a diaphragm plate extending across the covers and being secured therebetween when the covers are fastened together, the diaphragm plate having a plurality of similarly defined circular regions, the front cover having substantially axially aligned inlet and outlet ports, each leading to mutually exclusive inlet and outlet chambers respectively, a valve housing securable inside the front cover and having defined therein an outlet dished valve seat with a correspondingly concave resilient valve seated therein, the outlet valve seating having fluid passages therethrough, and a plurality of inlet valve seats, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein, each inlet valve seat having fluid passages therethrough, the outlet valve being in fluid communication with the outlet chamber and the inlet valves being in fluid communication with the inlet chamber, and a wobble plate

positioned in the back cover and having a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm, the piston sections and circular regions being correspondingly secured together, the wobble plate being subject to nutating motion to cause reciprocating action by the circular regions and provide a pumping action.

Page 3, between paragraphs [0005] and [0006]:

[0005.5] BRIEF DESCRIPTION OF THE DRAWINGS

paragraph [0009]:

[0009] Figs. 3A and 3B are respectively exploded perspective views from above and from below of a valve housing of the pump;

Page 4, between paragraphs [0015] and [0016]:

[0015.5] DESCRIPTION ON THE PREFERRED EMBODIMENTS

paragraph [0017]:

[0017] The front cover 10 has substantially axially aligned inlet and outlet ports 18, 20, each leading to a mutually exclusive inlet and outlet chambers 22,24, respectively. The outlet chamber 24 is provided centrally of the front cover 10 and has a wall surround 25 through which the outlet port 20 communicates. The inlet chamber 22 is defined between the wall surround 25 and [a wall] the sidewall of the front cover 10.

paragraph [0018]:

[0018] A valve housing 26 is substantially planar and is secured inside the front cover 10 and has defined therein on one side an outlet dished valve seat 28 with a correspondingly concave resilient valve 30 seated therein. The outlet valve seat 28 has a gridded area 32 forming fluid passages therethrough and a central hole 72. On the

opposite side of the housing 26, a plurality of four inlet valve seats 34 are provided, each being similarly dished and having a corresponding concave resilient valve 36 seated therein, each inlet valve seat 34 having arcuate gridded areas 38 forming fluid passages therethrough and a central hole 73. The outlet valve seat 28 is in fluid communication with outlet chamber 24 and the inlet valve seats 34 are in fluid communication with the inlet chamber 22. Each valve 30 and 36 is formed of a dished, part-spherical portion having a post 35 radially outstanding from its rear convex face, the post having bulbous portion 37, the valve being seated by the post 35 being pushed through the hole 72,73 respectively with the bulbous portion 37 holding the valve in position preventing unintentional removal.

Page 5, paragraph [0023]:

[0023] The back cover 12 of the casing is secured to an electric motor 76 with the drive shaft connected via an eccentric 78 to the bearing 54 through the back cover 12. The eccentric 78 has a knurled portion 79 to fit into the wobble plate 40 with the drive shaft of the motor [locating] located in bore 81. The motor 76 has a mounting bracket 56 with a series of mounting feet 58 fitted thereto, the feet 58 each being substantially ovoid in plan and of resilient material to dampen vibratory movement. The greater dimensioned end of each foot 58 has an upstanding headed stub pillar 60, the pillar 60 mating in an open slot 62 in the bracket 56. The slot 62 is narrower at its open end to hold the respective foot 58 in the slot. The feet 58 are similarly provided with two fixing holes 64 at their narrower end and being capable of rotating in and about their respective mating slot 62.

Page 6, paragraph [0024]:

[0024] The valve housing 26 is fixed to the front cover 10 by a screw (not shown). An integral pressure switch (not shown) is provided in the back cover 12 with the diaphragm plate 14 being provided with a fifth defined circular region 66, smaller than the other regions 16, the rear diaphragm support plate 50 having a similarly shaped aperture 68 with wall surround to accommodate the circular region 66. A micro-switch (not shown) is retained in an enclosure 82 on the back cover 12 by an upstand 80 in the rear diaphragm support plate 50, and is activated by movement of the fifth circular region 66 serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor. The valve housing 26, on the same side as the inlet valve seats 34 are positioned, is provided with a track 70 between two inlet valve seats 34 leading from a hole 72 exiting on that side and centrally provided in the outlet valve seat 28 provided on the opposite side, the track 70 mating with a corresponding track 74 provided on the diaphragm plate 14. The mated tracks 70, 74 form a passage between the hole 72 and the fifth circular region 66 whereby any fluid leaving the outlet chamber 24 when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate 14 from the pressure switch causing activation of the micro-switch to stop the pump.

Page 7, after paragraph [0029]:

[0030] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

[Abstract] **ABSTRACT OF THE DISCLOSURE**

A diaphragm pump comprises a two part casing formed of a front cover [(10)] and a back cover [(12)]. A diaphragm plate [(14)] extends across the covers [(10,12)] and is secured therebetween when the covers [(10,12)] are fastened together. The diaphragm plate [(14)] has a plurality of similarly defined circular regions [(16)]. The front cover [(10)] has substantially axially aligned inlet and outlet ports [(18)], each leading to mutually exclusive inlet and outlet chambers [(22,24)] respectively. A valve housing [(26)] is securable inside the front cover [(10)] and has defined therein an outlet dished valve seat (28) with a correspondingly concave resilient valve (30) seated therein. The outlet valve seat [(28)] has fluid passages therethrough. A plurality of inlet valve seats [(34)] is provided, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve [(36)] seated therein. Each inlet valve seat (34) has fluid passages therethrough. The outlet valve [(30)] is in fluid communication with the outlet chamber [(24)] and the inlet valves [(36)] are in fluid communication with the inlet chamber [(22)]. A wobble plate [(40)] is positioned in the back cover [(12)] and has a central boss [(42)] and a plurality of similar piston sections [(44)] equal in number to the number of circular regions [(16)] on the diaphragm plate [(14)]. The piston sections [(44)] and circular regions [(16)] are correspondingly secured together. The wobble plate [(40)] is subject to nutating motion to cause reciprocating action by the circular regions [(16)] and provide a pumping action.

DIAPHRAGM PUMPS

This invention relates to a diaphragm pump incorporating a wobble plate.

Accordingly, the present invention is a diaphragm pump comprising a two part casing formed of a front cover and a back cover, a diaphragm plate extending across the covers and being secured therebetween when the covers are fastened together, the diaphragm plate having a plurality of similarly defined circular regions, the front cover having substantially axially aligned inlet and outlet ports, each leading to mutually exclusive inlet and outlet chambers respectively, a valve housing securable inside the front cover and having defined therein an outlet dished valve seat with a correspondingly concave resilient valve seated therein, the outlet valve seating having fluid passages therethrough, and a plurality of inlet valve seats, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein, each inlet valve seat having fluid passages therethrough, the outlet valve being in fluid communication with the outlet chamber and the inlet valves being in fluid communication with the inlet chamber, and a wobble plate positioned in the back cover and having a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm, the piston sections and circular regions being correspondingly secured together, the wobble plate being subject to nutating motion to cause reciprocating action by the circular regions and provide a pumping action.

Preferably, the circular regions of the diaphragm are each provided with an outstanding lug formation and the mating surfaces of the piston sections of the wobble plate are provided with complimentary shaped slots, the securement being formed when the lug formation of each region is engaged in the slot of the

corresponding piston section. The lug formation of each diaphragm and the slot of each corresponding piston section is beneficially of cruciform shape. The outer ends of the lug formation are desirably of greater length than the slots to provide a locking means in the slots. A rear diaphragm support plate may be provided in the back cover, the support plate having an equal number of similar apertures to the number of circular regions, each aperture having a walled surround, the circular regions fitting into respective apertures and being supported thereby.

Preferably also, the wobble plate boss seats and holds a bearing having a ball race, the boss having an inwardly-extending retaining flange.

Preferably also, the casing is secured to an electric motor with the drive shaft connected to the bearing. The casing has desirably a mounting bracket with a series of mounting feet fitted thereto, the feet each being substantially ovoid in plan and of resilient material, the greater dimensioned end having an upstanding headed stub pillar, each pillar mating in a open slot in the bracket, the slot being narrower at its open end to hold the respective foot in its slot. The feet are desirably similarly provided with at least one fixing hole at their narrower end and being capable of rotating about their respective mating slot.

Preferably further, the valve housing is fixed to the front cover by a screw.

An integral pressure switch is beneficially provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch activated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor. The valve housing, on the same side as the inlet valve seats are positioned, is preferably provided with a track leading from a hole exiting on that side and centrally provided in the outlet valve seat

provided on the opposite side, the track mating with a corresponding track provided on the diaphragm plate, the mated tracks forming a passage between the hole and the fifth circular region whereby any fluid leaving the outlet chamber when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate from the pressure switch causing activation of the micro-switch to stop the pump.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figs. 1A and 1B are perspective views from above and from below of a front cover of a diaphragm pump according to the present invention;

Figs. 2A and 2B are respectively perspective views from above and from below of a back cover of the pump;

Figs. 3A and 3B are respectively perspective views from above and from below of a valve housing of the pump;

Figs. 4A and 4B are respectively perspective views from above and from below of a diaphragm plate of the pump;

Figs. 5A and 5B are respectively perspective views from above and from below of a diaphragm support plate of the pump;

Figs. 6A, 6B and 6C are respectively a perspective view from above, a perspective view from below, and a cross-sectional view of a wobble plate of the pump;

Figs. 7A and 7B are respectively a perspective view from above and from below of an eccentric positioned between a wobble plate and the drive shaft of an electric motor;

Fig 8 is a perspective view of an assembled pump; and

Fig. 9 is a modified diaphragm support plate,

Referring to the drawings, a diaphragm pump comprises a two part casing formed of a front cover 10 and a back cover 12. A diaphragm plate 14 extends across and between the covers 10, 12 and is secured therebetween when the covers 10, 12 are fastened together by screw fasteners 13. The diaphragm plate 14 has a plurality of four similarly defined circular regions 16.

The front cover 10 has substantially axially aligned inlet and outlet ports 18, 20, each leading to a mutually exclusive inlet and outlet chambers 22, 24, respectively. The outlet chamber 24 is provided centrally of the front cover 10 and has a wall surround 25 through which the outlet port 20 communicates. The inlet chamber 22 is defined between the wall surround 25 and a wall of the front cover 10.

A valve housing 26 is substantially planar and is secured inside the front cover 10 and has defined therein on one side an outlet dished valve seat 28 with a correspondingly concave resilient valve 30 seated therein. The outlet valve seat 28 has a gridded area 32 forming fluid passages therethrough and a central hole 72. On the opposite side of the housing 26, a plurality of four inlet valve seats 34 are provided, each being similarly dished and having a correspondingly concave resilient valve 36 seated therein, each inlet valve seat 34 having arcuate gridded areas 38 forming fluid passages therethrough and a central hole 73. The outlet valve seat 28 is in fluid communication with the outlet chamber 24 and the inlet valve seats 34 are in fluid communication with the inlet chamber 22. Each valve 30 and 36 is formed of a dished, part-spherical portion having a post 35 radially outstanding from its rear face, the post having a bulbous portion 37, the valve being seated by the post 35 being pushed through the hole 72, 73 respectively with the bulbous portion 37 holding the valve in position preventing unintentional removal.

A wobble plate 40 is positioned in the back cover 12 and has a central boss 42 and a plurality of four similar piston sections 44. The piston sections 44 and

circular regions 16 are correspondingly secured together. The wobble plate 40 is subject to nutating motion, like 'four cylinders', to cause reciprocating action by the circular regions 16 of the diaphragm plate 14 sequentially and provide a pumping action.

5 The circular regions 16 of the diaphragm 14 are each provided with an outstanding lug formation 46 and the mating surfaces of the piston sections 44 of the wobble plate 40 are provided with complementary shaped slots 48. The securement between them is formed when the lug formation 46 of each region 16 is engaged in the slot 48 of the corresponding piston section 44. The lug formation 46 of each
10 diaphragm 14 and the slot 48 of each corresponding piston section 44 is of cruciform shape. The outer ends of the lug formation 46 are of greater length than the slots 48 to provide a locking means with the slots 48.

A rear diaphragm support plate 50 is provided in the back cover 12, the support plate 50 having four similar apertures 52. Each aperture 52 has a walled
15 surround with the circular regions 16 fitting into respective apertures 52.

The boss 42 of the wobble plate 40 seats and holds by an inwardly-extending retaining flange 56 a bearing 54 having a ball race, the bearing 54 having been insert moulded in the boss 42.

The back cover 12 of the casing is secured to an electric motor 76 with the
20 drive shaft connected via an eccentric 78 to the bearing 54 through the back cover 12. The eccentric 78 has a knurled portion 79 to fit into the wobble plate 40 with the drive shaft of the motor locating in bore 81. The motor 76 has a mounting bracket 56 with a series of mounting feet 58 fitted thereto, the feet 58 each being substantially ovoid in plan and of resilient material to dampen vibratory movement.
25 The greater dimensioned end of each foot 58 has an upstanding headed stub pillar 60, the pillar 60 mating in an open slot 62 in the bracket 56. The slot 62 is narrower

at its open end to hold the respective foot 58 in the slot. The feet 58 are similarly provided with two fixing holes 64 at their narrower end and being capable of rotating in and about their respective mating slot 62.

The valve housing 26 is fixed to the front cover 10 by a screw (not shown).

- 5 An integral pressure switch (not shown) is provided in the back cover 12 with the diaphragm plate 14 being provided with a fifth defined circular region 66, smaller than the other regions 16, the rear diaphragm support plate 50 having a similarly shaped aperture 68 with wall surround to accommodate the circular region 66. A micro-switch (not shown) is retained in an enclosure 82 on the back cover 12 by an
- 10 upstand 80 in the rear diaphragm support plate 50 is activated by movement of the fifth circular region 66 serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor. The valve housing 26, on the same side as the inlet valve seats 34 are positioned, is provided with a track 70 between two inlet valve seats 34 leading from a hole 72 exiting on that side
- 15 and centrally provided in the outlet valve seat 28 provided on the opposite side, the track 70 mating with a corresponding track 74 provided on the diaphragm plate 14. The mated tracks 70, 74 form a passage between the hole 72 and the fifth circular region 66 whereby any fluid leaving the outlet chamber 24 when under pressure through the screw travels along the passage and fills a void at the pressure pad on
- 20 the opposite side of the diaphragm plate 14 from the pressure switch causing activation of the micro-switch to stop the pump.

- In use, with the inlet and outlet ports connected to a supply source and a demand requirement and the motor connected up to a supply of electricity, the pump can be switched on to pump, in an even flow, fluid, normally water, from the supply
- 25 source. The motor drives the wobble plate to nutate and reciprocate the piston sections and circular regions of the diaphragm plate in a pumping action.

In a first modification, the concave resilient valve 30 and post 35 is provided with a bore strengthened by a metallic tubular liner through which the valve 30 and valve housing 26 is secured by a fastening (not shown) through a washer to the front cover 10.

5 In a second modification, the valve housing 26, the diaphragm plate 14 and the diaphragm support plate 50 are provided with five apertures (not shown) and are secured together by five fastenings (not shown) into respective bosses 90 provided on the support plate 50 (as shown in Fig. 9), the fastenings being fixed in the opposite direction to the fastening of the valve housing 26 and valve 30.

10 In a third modification, the lug formations 46 and slots 48 are omitted and the piston sections 44 are each screw fastened to respective circular regions 16 of the diaphragm 14.

Variations and modifications can be made without departing from the scope of the invention described above and as claimed hereinafter.

15

CLAIMS

1. A diaphragm pump comprising a two part casing formed of a front cover and a back cover, a diaphragm plate extending across the covers and being secured
5 therebetween when the covers are fastened together, the diaphragm plate having a plurality of similarly defined circular regions, the front cover having substantially axially aligned inlet and outlet ports, each leading to mutually exclusive inlet and outlet chambers respectively, a valve housing securable inside the front cover and having defined therein an outlet dished valve seat with a correspondingly concave
10 resilient valve seated therein, the outlet valve seating having fluid passages therethrough, and a plurality of inlet valve seats, equal in number to the number of regions, each being similarly dished and having a correspondingly concave resilient valve seated therein, each inlet valve seat having fluid passages therethrough, the outlet valve being in fluid communication with the outlet chamber and the inlet valves
15 being in fluid communication with the inlet chamber, and a wobble plate positioned in the back cover and having a central boss and a plurality of similar piston sections equal in number to the number of circular regions on the diaphragm, the piston sections and circular regions being correspondingly secured together, the wobble plate being subject to nutating motion to cause reciprocating action by the circular
20 regions and provide a pumping action.
2. A pump as claimed in Claim 1, wherein the circular regions of the diaphragm are each provided with an outstanding lug formation and the mating surfaces of the piston sections of the wobble plate are provided with complimentary shaped slots,
25 the securement being formed when the lug formation of each region is engaged in the slot of the corresponding piston section.

3. A pump as claimed in Claim 2, wherein the lug formation of each diaphragm and the slot of each corresponding piston section is of cruciform shape.
- 5 4. A pump as claimed in Claim 2 or 3, wherein the outer ends of the lug formation are of greater length than the slots to provide a locking means in the slots.
5. A pump as claimed in Claim 1, 2 or 3, wherein a rear diaphragm support plate
- 10 is provided in the back cover, the support plate having an equal number of similar apertures to the number of circular regions, each aperture having a walled surround, the circular regions fitting into respective apertures and being supported thereby.
6. A pump as claimed in any one of the preceding Claims, wherein the wobble
- 15 plate boss seats and holds a bearing having a ball race, the boss having an inwardly-extending retaining flange.
7. A pump as claimed in any one of the preceding Claims, wherein the casing is secured to an electric motor with the drive shaft connected to the bearing.
- 20
8. A pump as claimed in any one of the preceding Claims, wherein the casing has a mounting bracket with a series of mounting feet fitted thereto, the feet each being substantially ovoid in plan and of resilient material, the greater dimensioned end having an upstanding headed stub pillar, each pillar mating in a open slot in the
- 25 bracket, the slot being narrower at its open end to hold the respective foot in its slot.

9. A pump as claimed in Claim 8, wherein the feet are similarly provided with at least one fixing hole at their narrower end and being capable of rotating about their respective mating slot.

5

10. A pump as claimed in any one of the preceding Claims, wherein the valve housing is fixed to the front cover by a screw.

11. A pump as claimed in any one of the preceding Claims, wherein an integral pressure switch is provided in the back cover with the diaphragm plate being provided with a fifth defined circular region, smaller than the others, the rear diaphragm support plate having a similarly shaped aperture with wall surround to accommodate a micro-switch activated by movement of the fifth circular region serving as a pressure switch pad, the electrical wires to the micro-switch being fed internally from the front face of the motor.

12. A pump as claimed in any one of the preceding Claims, wherein the valve housing, on the same side as the inlet valve seats are positioned, is provided with a track leading from a hole exiting on that side and centrally provided in the outlet valve seat provided on the opposite side, the track mating with a corresponding track provided on the diaphragm plate, the mated tracks forming a passage between the hole and the fifth circular region whereby any fluid leaving the outlet chamber when under pressure through the screw travels along the passage and fills a void at the pressure pad on the opposite side of the diaphragm plate from the pressure switch causing activation of the micro-switch to stop the pump.

13. A diaphragm pump substantially as hereinbefore described with reference to the accompanying drawings.

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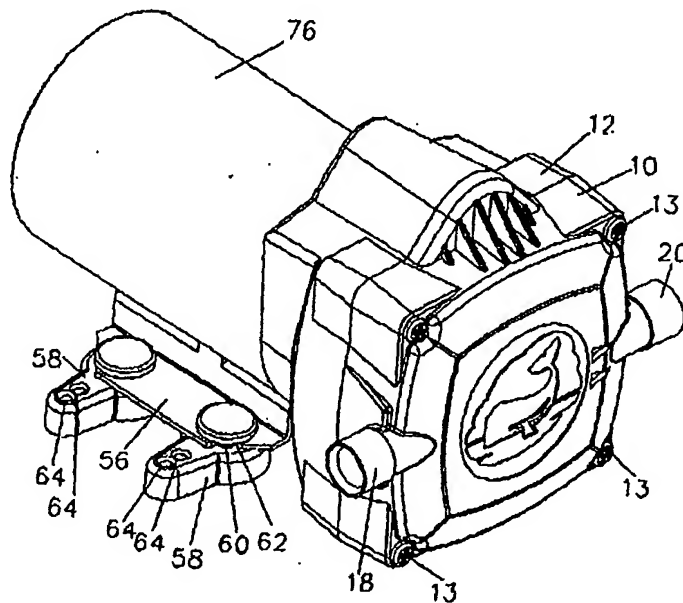
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(54) Title: DIAPHRAGM PUMPS



(57) Abstract: A diaphragm pump comprises a two part casing formed of a front cover (10) and a back cover (12). A diaphragm plate (14) extends across the covers (10, 12) and is secured therebetween when the covers (10, 12) are fastened together. The diaphragm plate (14) has a plurality of similarly defined circular regions (16). The front cover (10) has substantially axially aligned inlet and outlet ports (18), each leading to mutually exclusive inlet and outlet chambers (22, 24) respectively. A valve housing (26) is securable inside the front cover (10) and has defined therein an outlet dished valve seal (28) with a correspondingly concave

[Continued on next page]

WO 01/09510 A2

1/7

FIG.1A

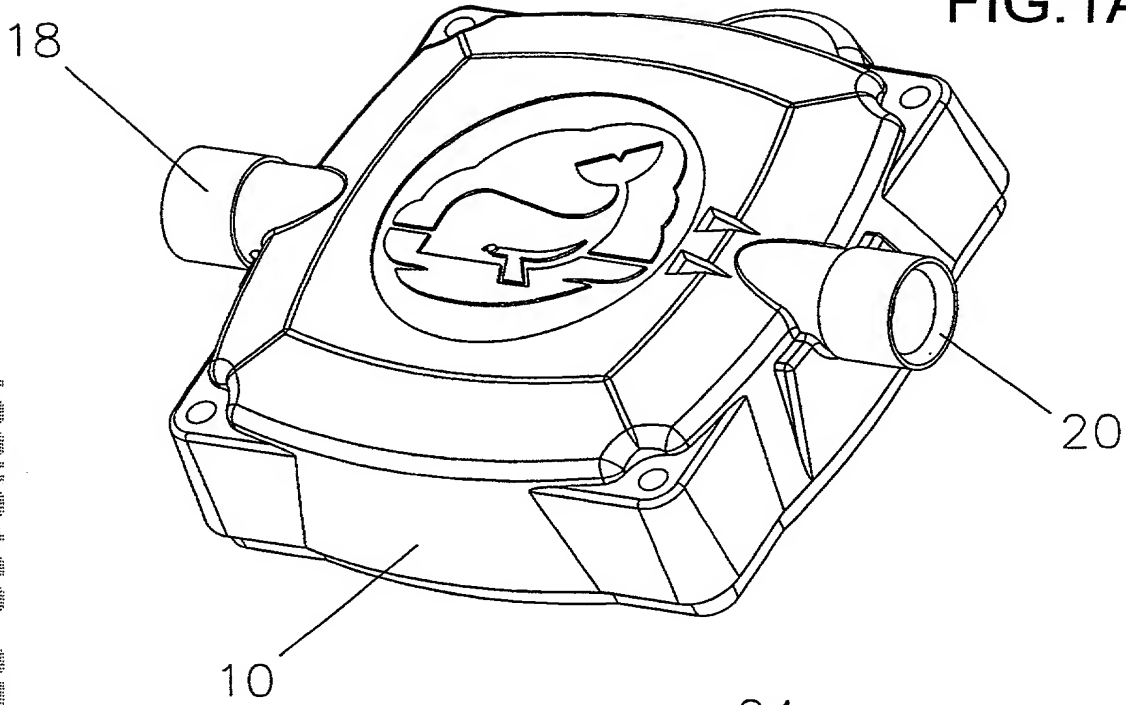
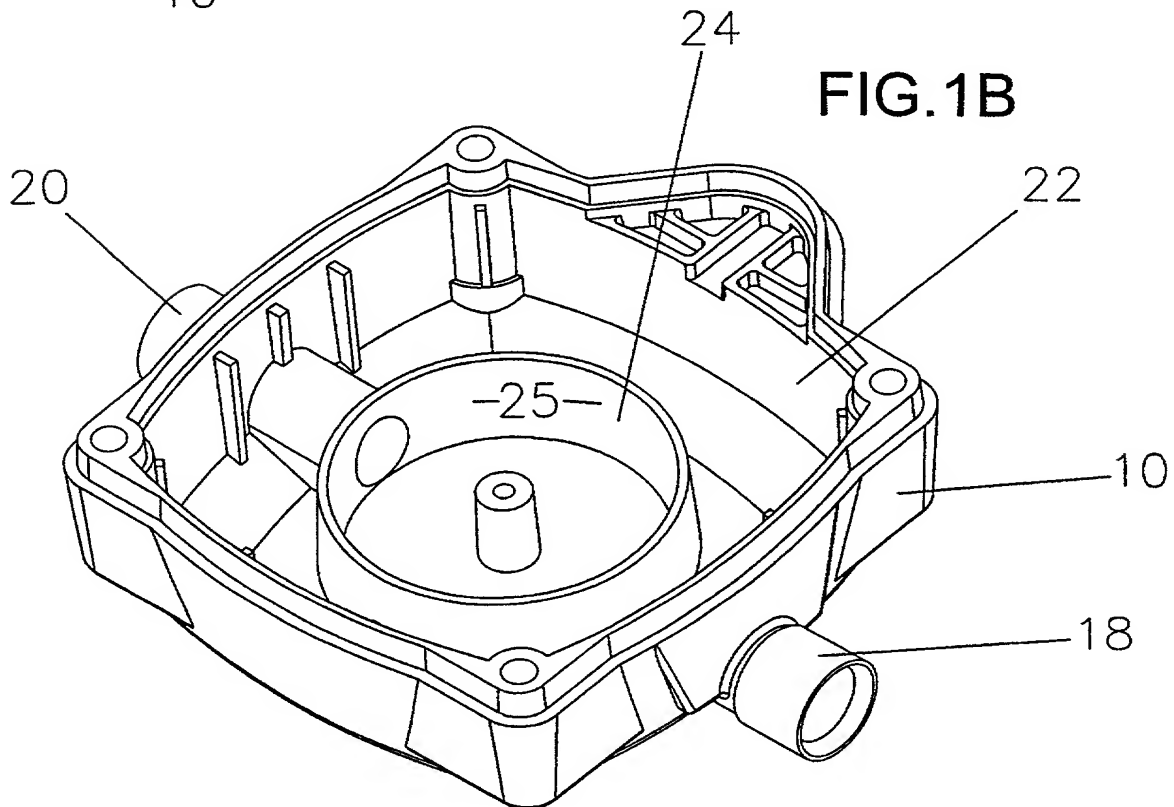


FIG.1B



2/7

FIG.2A

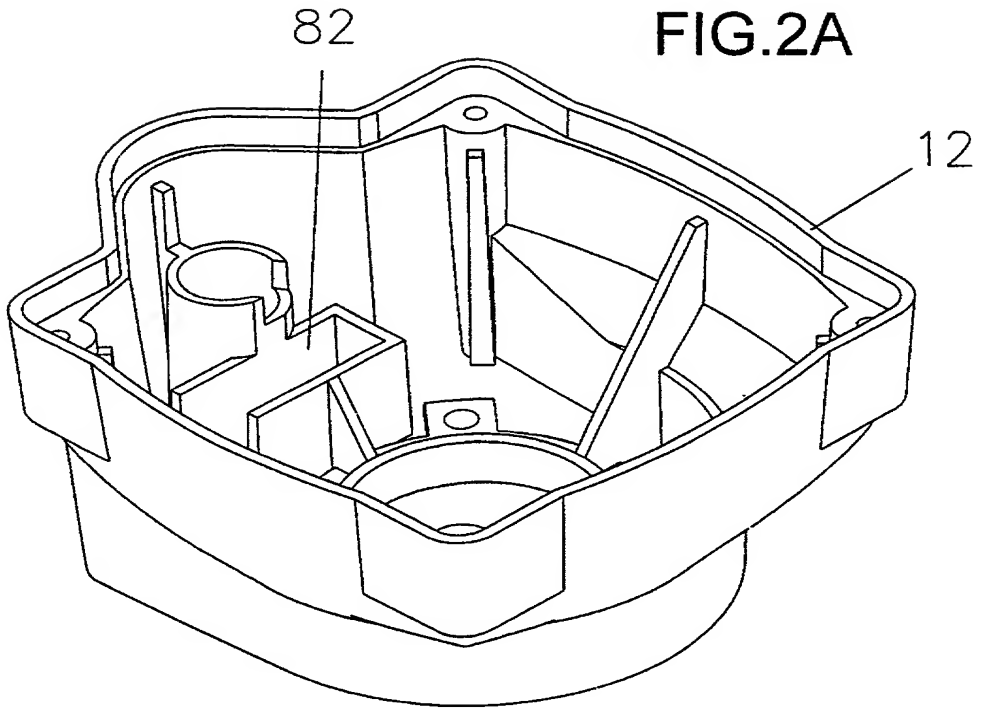
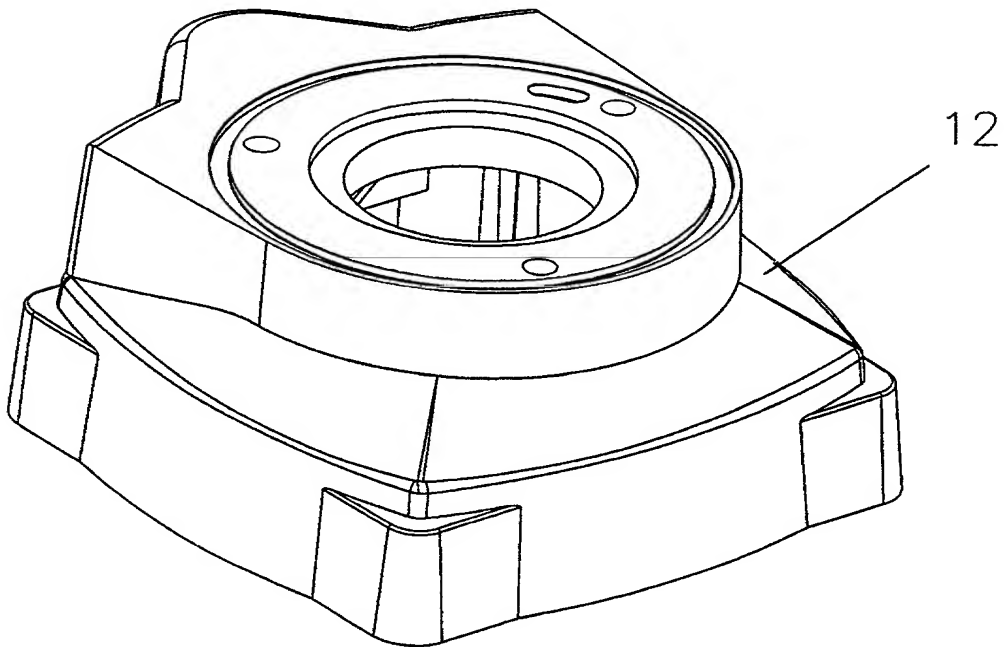


FIG.2B



3/7

FIG.3A

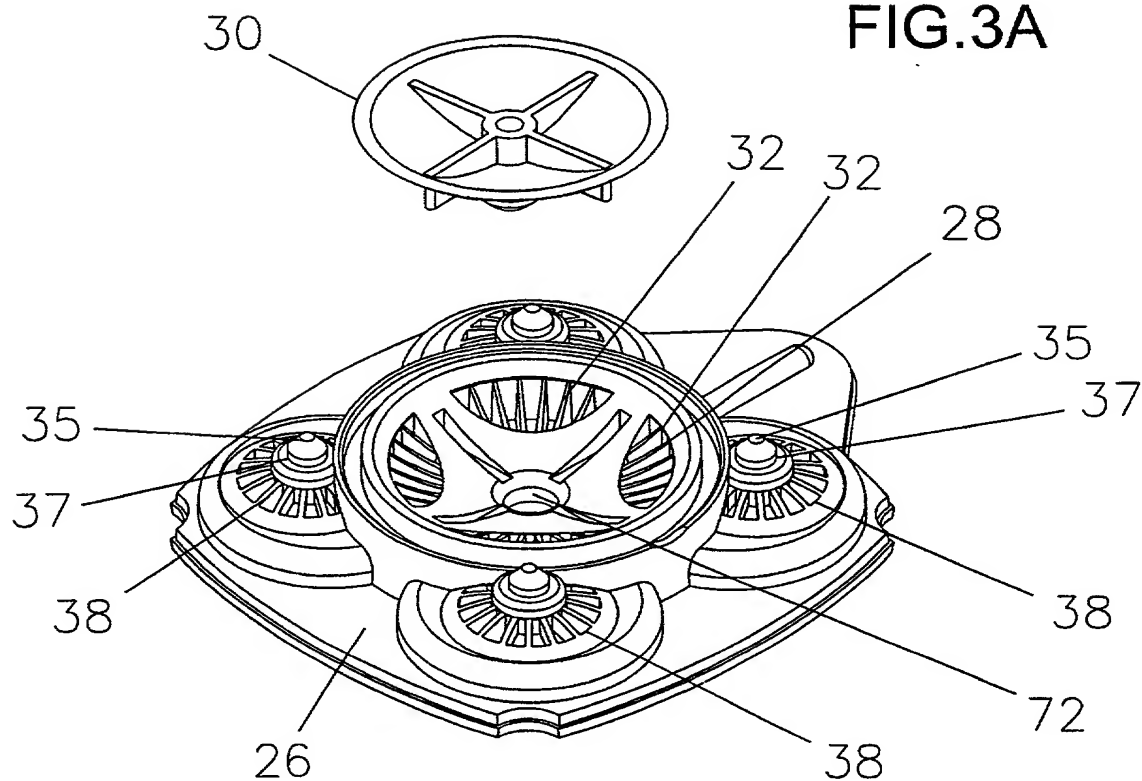


FIG.3B

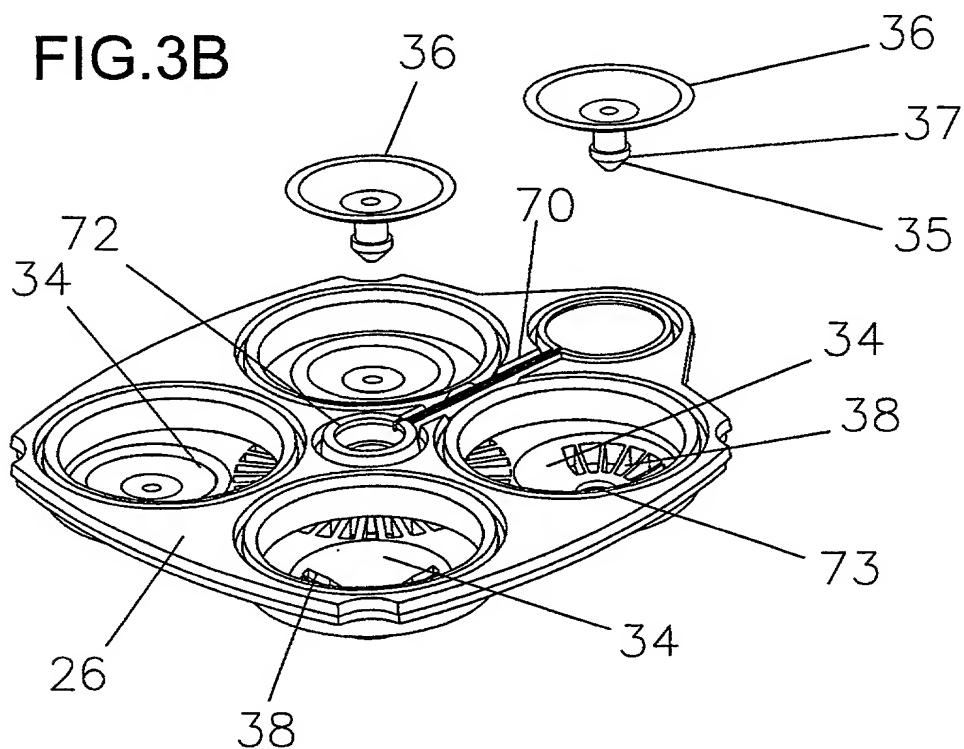


FIG.4A

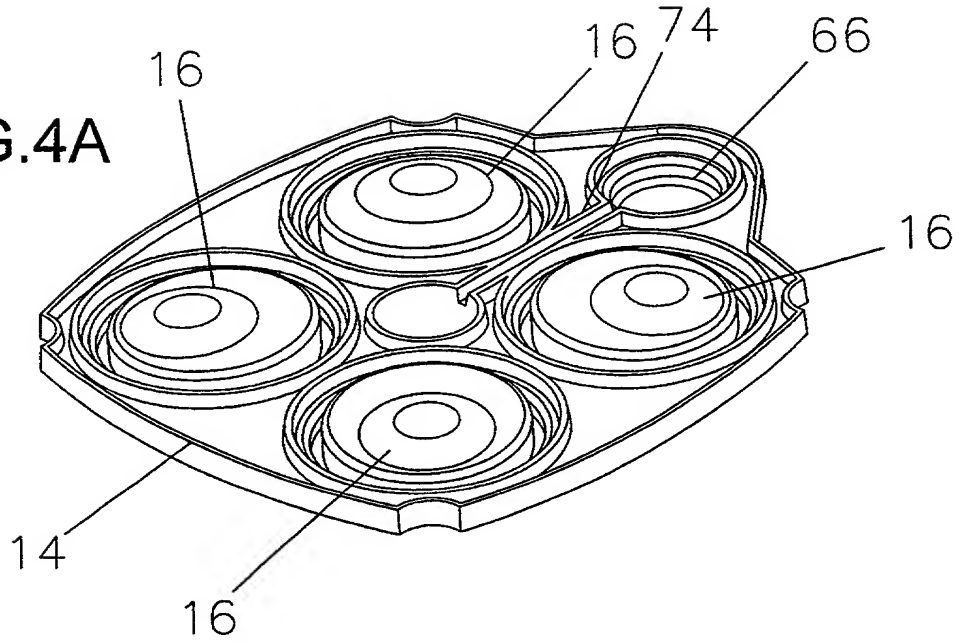


FIG.4B

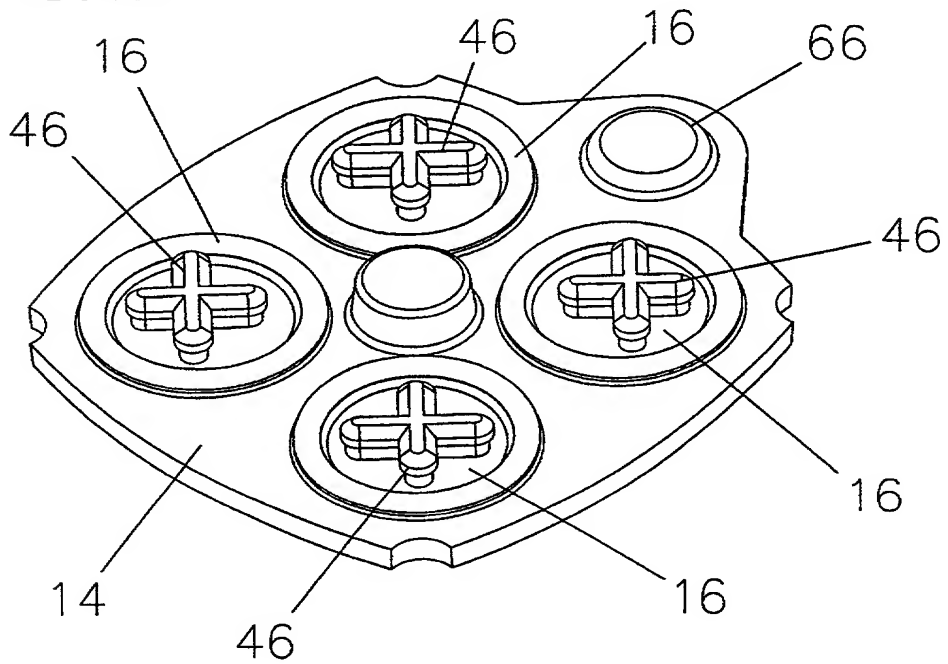


FIG.5A

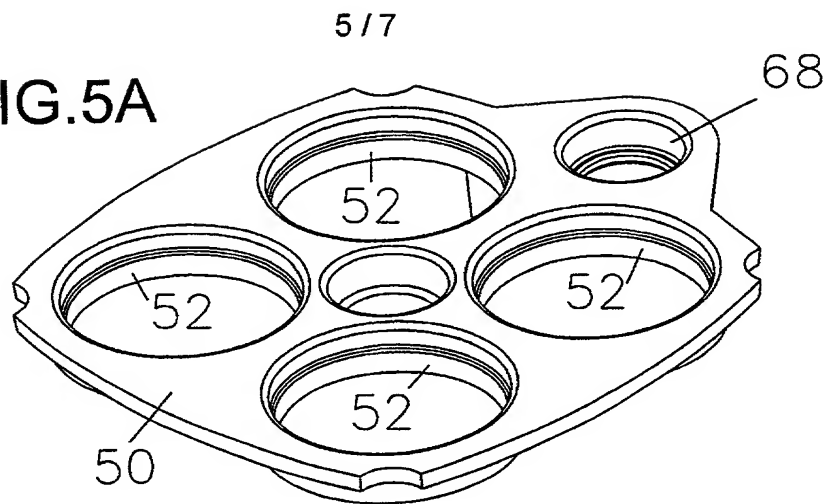


FIG.5B

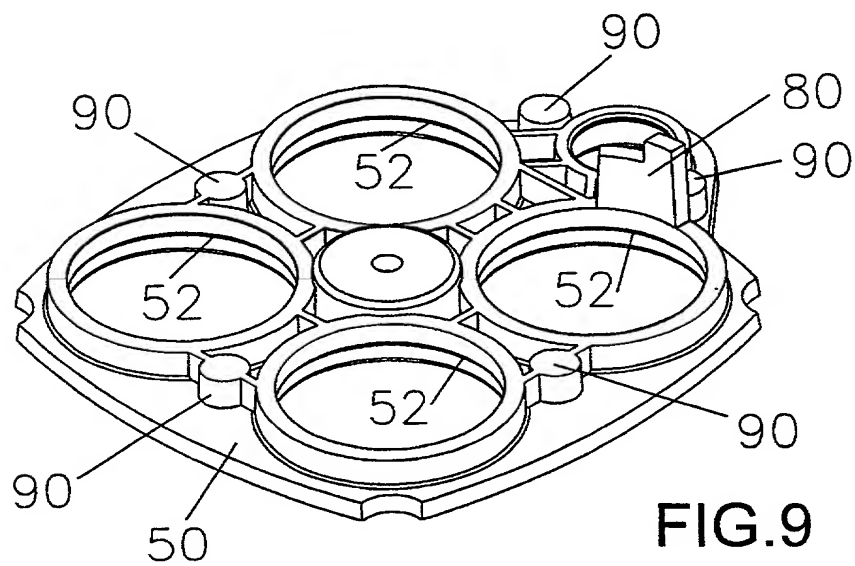
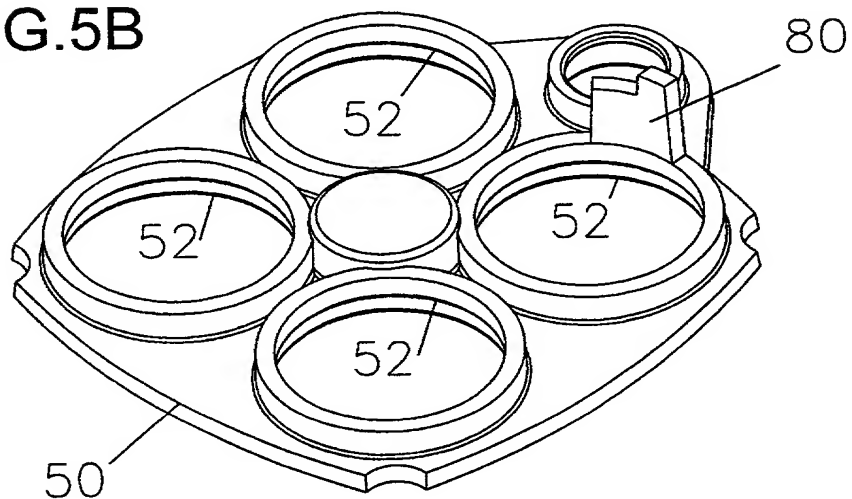


FIG.9

6/7

FIG.6A

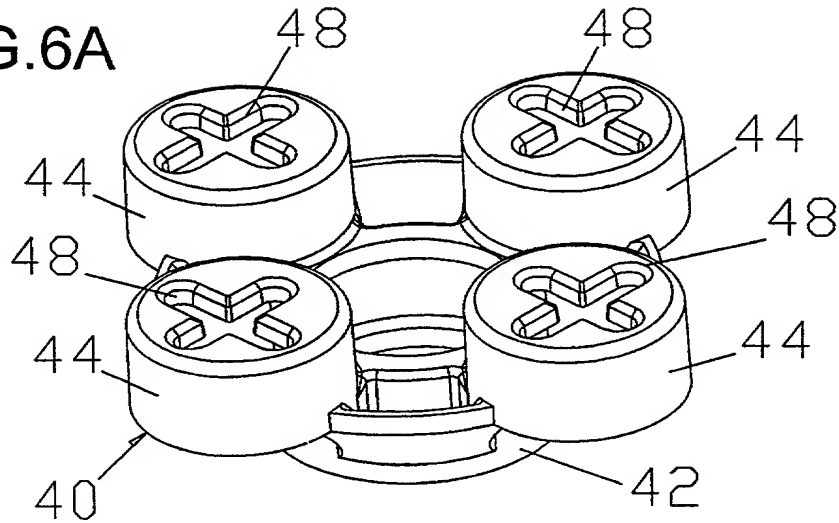


FIG.6B

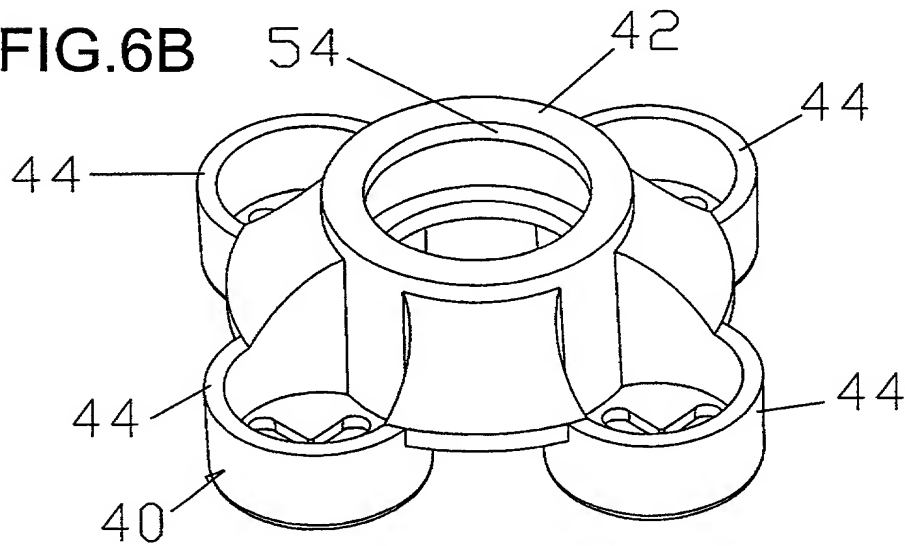
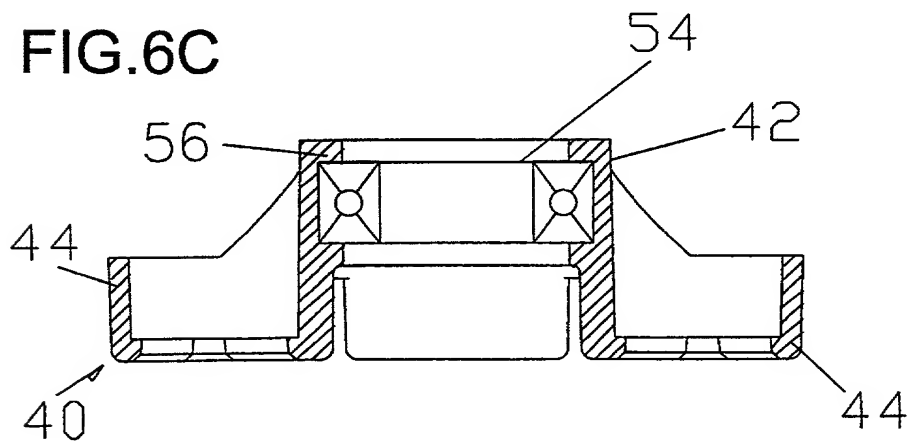


FIG.6C



7/7

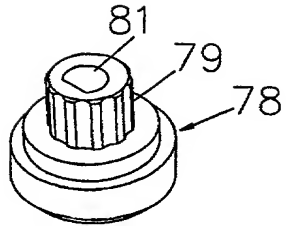


FIG. 7A

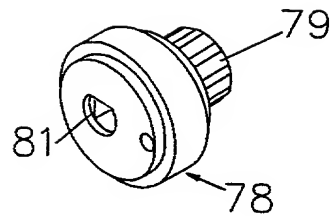


FIG. 7B

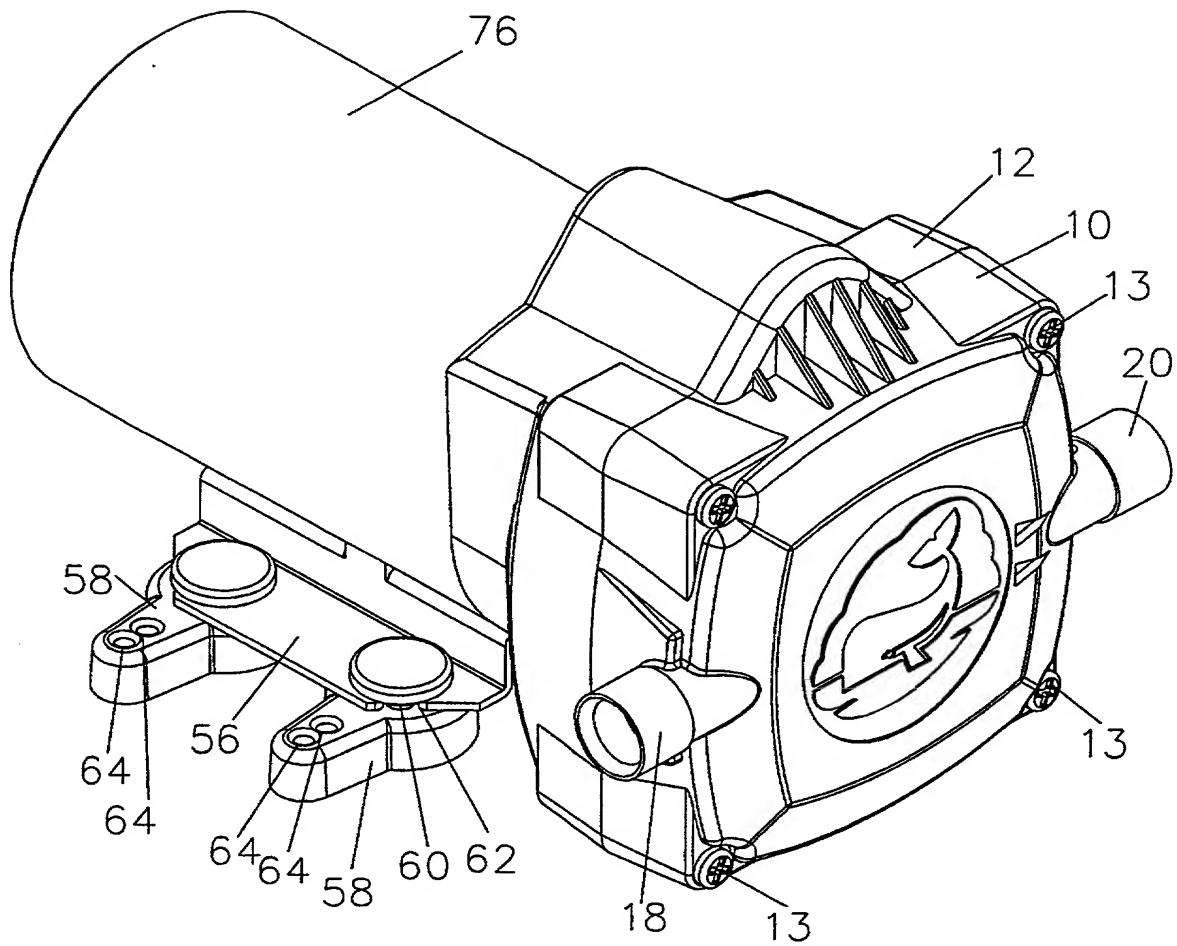


FIG. 8

STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR

02:13

Serial No.
10/048,160

Filing Date

Patent No.

Issue Date

Applicant/

Patentee: Stephen Macauley, Michael Evason and Robert Stanley McFarland

Invention:

DIAPHRAGM PUMPS

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☐ the specification to be filed herewith.
☒ the application identified above.
☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☐ No such person, concern or organization exists.
☐ Each such person, concern or organization is listed below.

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME
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ADDRESS☐ Individual ☐ Small Business Concern ☐ Nonprofit OrganizationFULL NAME
ADDRESS☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Stephen Macauley

SIGNATURE OF INVENTOR S Macauley

DATE: 6/2/02

NAME OF INVENTOR Michael Evason

SIGNATURE OF INVENTOR M Evason

DATE: 30/1/02

NAME OF INVENTOR Robert Stanley McFarland

SIGNATURE OF INVENTOR R. S. McFarland

DATE: 29-1-02

NAME OF INVENTOR _____

SIGNATURE OF INVENTOR _____

DATE: _____

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DATE: _____

02.13

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled DIAPHRAGM PUMPS

the specification of which

(check one)

☐ is attached hereto.

☐ was filed on 28th July 2000 as United States Application No. or PCT International Application Number PCT/GB00/02868

☐ and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

| Prior Foreign Application(s) | Priority | Claimed |
|------------------------------|-----------------------------------|---|
| <u>9917736.2</u> (Number) | <u>Great Britain</u> (Country) | <u>29th July 1999</u> (Day/Month/Year Filed) |
| | | <input checked="" type="checkbox"/> |
| <u></u> (Number) | <u></u> (Country) | <u></u> (Day/Month/Year Filed) |
| | | <input type="checkbox"/> |
| <u></u> (Number) | <u></u> (Country) | <u></u> (Day/Month/Year Filed) |
| | | <input type="checkbox"/> |

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Ronald E. Greigg - Registration No. 31,517

1

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Ronald E. Greigg - (703) 838-5500/Telephone - (703) 838-5554/Facsimile

| | | |
|-------------------------------------|--|-----------------------|
| Full name of sole or first inventor | <u>Stephen Macauley</u> | |
| Sole or first inventor's signature | <u>S Macauley</u> | Date <u>6/2/02</u> |
| Residence | <u>Old Belfast Road, Bangor, BT19 1LT, County Down, Northern Ireland, U.K.</u> | |
| Citizenship | <u>BRITISH</u> | <u>GBX</u> |
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| Second inventor's signature | <u>M EVASON</u> | Date <u>30/1/02</u> |
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| Full name of third inventor, if any | |
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| Third inventor's signature | Date |
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| Full name of fourth inventor, if any | |
| Fourth inventor's signature | Date |
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| Citizenship | |
| Post Office Address | |

| | |
|-------------------------------------|------|
| Full name of fifth inventor, if any | |
| Fifth inventor's signature | Date |
| Residence | |
| Citizenship | |
| Post Office Address | |

| | |
|-------------------------------------|------|
| Full name of sixth inventor, if any | |
| Sixth inventor's signature | Date |
| Residence | |
| Citizenship | |
| Post Office Address | |